

Morphological characteristics of green spaces in fortified towns and cities

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Revised version received 8 September 2018

Abstract. *This research focuses on morphological aspects of green spaces in 26 fortified European towns and cities. Such spaces are insufficiently acknowledged for the identities they confer and the advantages they provide for inhabitants. They are integral parts of inner urban fringe belts, and they are important both functionally and as attributes of heritage. Important aspects of these green spaces include their place within the system of defences, their various types of past and present utilization, their significance within the urban tissue and the need for their careful conservation.*

Keywords: city walls, historical towns, morphological characteristics, green spaces, fringe belts

Green spaces are part of the historical character and distinctive identities of towns and cities. They are as important in this respect as are historical streets and buildings. The term ‘green spaces’ may be defined as ‘land that consists predominantly of permeable, soft surfaces such as soil, grass, shrubs and trees’. An operative term is ‘predominant’ because green spaces may also include buildings and hard-surface areas (Dunnett *et al.*, 2002). They may or may not be accessible or publicly managed, and they may come into being in various ways, including planned cultivation or natural succession of vegetation. They have major potential for collective or individual use.

The built structures of the 26 urban areas analysed are predominantly medieval and Renaissance in origin, although some have even older antecedents. During long-lasting

sieges green spaces inside these historical areas were commonly used as agricultural land, meadows and occasionally as reserve plots for future urban expansion. Some of the land was converted into vineyards, gardens and pastures.

The morphological complexity of urban areas, particularly those with long histories, has long been recognized (Olivera, 2016). Urban tissue consists of a synthesis of elements – lines (streets, roads), spaces (street blocks, green areas) and points (notably buildings). Analysis of this tissue allows the physical characteristics of a town or city to be identified and described, and its character perceived. This is at the core of the urban morphologist’s perception of a settlement (Kropf, 1996), and fundamental to the approach adopted in this paper.

Motivation for research

This research originated in the medieval Croatian town of Ston, on the eastern Adriatic coast, which has a disproportionately large area of green space within its fortified area. Ston was built as a planned town, at the beginning of the fourteenth century (Planić-Lončarić, 1980, 1987) (Figure 1).

Such green spaces associated with town and city walls serve as a zone between the early and later parts of the urban area (Krajnik, 2011; Krajnik and Šćitaroci, 2008; Krajnik *et al.*, 2008). They present a challenge for decision-making about their subsequent use. Many fortified towns and cities in Europe underwent remodelling, extension and expansion (Whitehand and Alauddin, 1969). This was sometimes done at the expense of the green spaces inside the walls: fortifications were quite often dismantled in the process of expansion. However, Ston and a number of other historic Croatian towns did not experience great pressure to build and expand. In the case of Ston, it has remained isolated from major routes, even to this day. There were no industrial buildings nearby, unlike in many European, particularly British, urban areas which were greatly influenced by the free market (Conzen, 1981a).

Research focus

Analysis of green spaces associated with town and city walls revealed a number of evolutionary types, ranging from cases in which the green spaces have become dispersed within the urban tissue to those in which a continuous 'green belt' has been preserved associated with the wall. The present research focused on the cases in which a significant green belt has remained. These belts form a prominent aspect of morphological character and have considerable potential for public use. However, in many urban areas with green spaces inside the walls these spaces are not sufficiently recognized for their significance for the numerous functions they have that can positively affect the lives of inhabitants, for

example their ecological significance and the cohesive function that they can perform.

In this light, the research in this paper concerns primarily the significance of the green spaces inside the walls of urban areas with regard to their location, size and shape, and with special emphasis on large, compact green spaces in the intramural inner fringe belt (Conzen, 1960, pp. 58–9). This includes an analysis of the characteristics of these spaces and their relationship to the built-up area, with an emphasis on function and spatial connection. Green spaces are an integral part of the urban environment, and townscape management should focus not only on renewing house façades, historic streets and town walls (Doratli, 2005). In scientific studies dealing with substantially degraded fortified urban areas, open spaces have been recognized as potentially cohesive formative elements (Doratli, 2005; Hazar and Kubat, 2015; Oktay and Conteh, 2007; Walsh *et al.*, 2012). Considering historical towns over half a century ago, Conzen noted that 'proper management of our townscapes is of special importance because of its direct effect on the quality of our environment and its long-term benefit to society, even though this benefit is not merely economic but is of an essentially social and cultural nature and as such it is difficult to express, and is certainly not adequately assessable, in monetary terms' (Conzen, 1966, p. 55).

Research aims

The aims of the present research were three-fold. The first was to assess the morphological and other features of green-space identity in intramural inner fringe-belt formation. The second was to find supporting arguments for the value and potential of these spaces within fortified towns. The third was to draw attention to the threats to depopulating towns – such as the Croatian towns of Ston, Nin and Cavtat – where the focus is largely on tourism.

By analysing green spaces inside fortified towns from the perspective of urban morphology, the fringe belts that contain such spaces

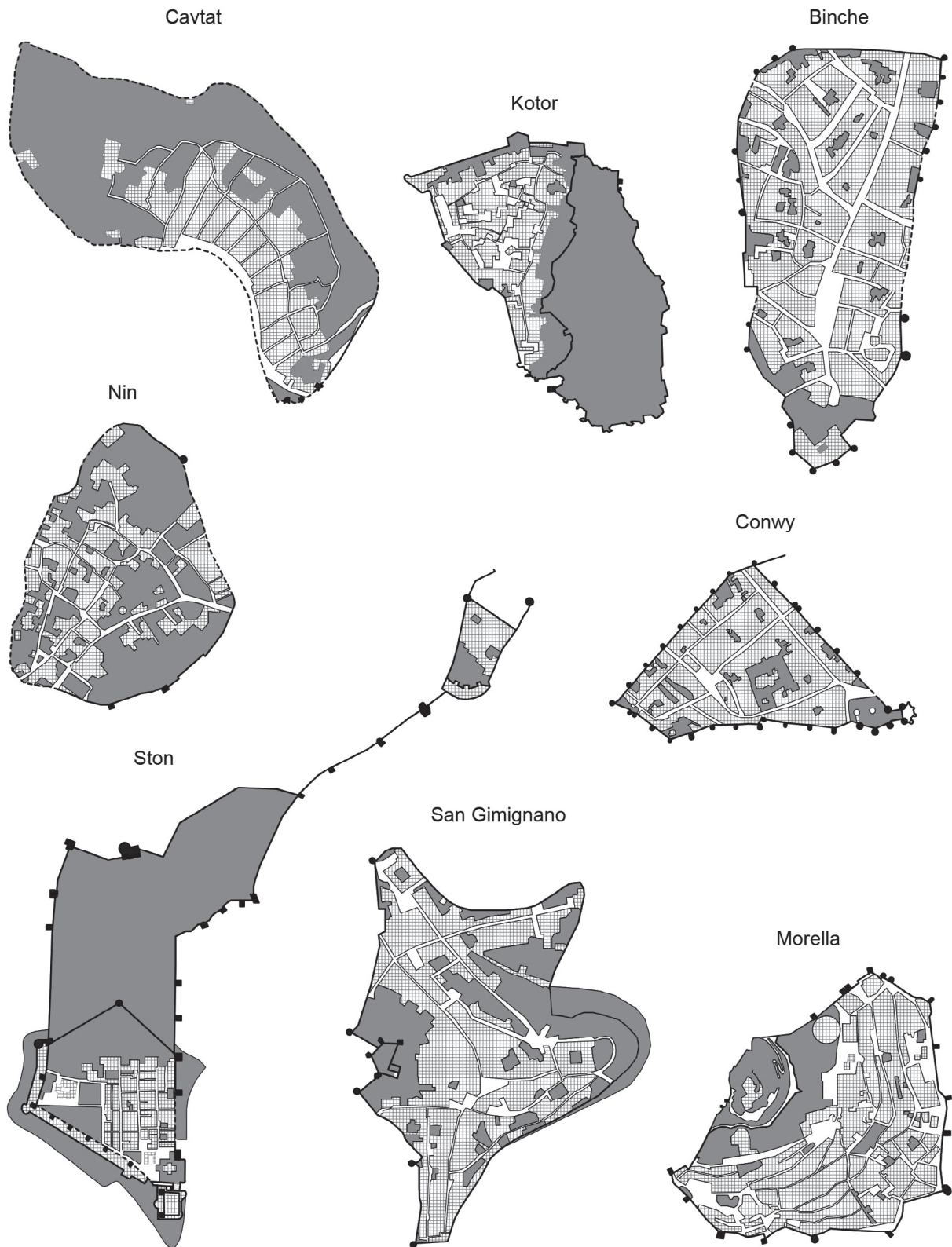
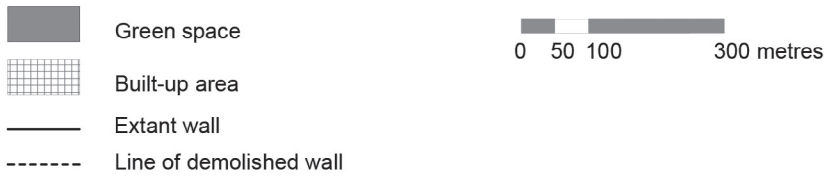


Figure 1. Green spaces in the urban tissue of the fortified towns of Cavtat, Nin, Ston, Kotor, Binche, Conwy, Morella and San Gimignano.

call for an agenda entailing integration into the urban tissue, preservation from fringe-belt alienation, and incorporation of the fringe-belt concept into urban planning and urban landscape management (Ducom, 2003, 2005; Hazar and Kubat, 2015; Whitehand and Gu, 2010).

Conceptual context and previous research

An important aspect of the conceptual framework of this research is the urban fringe-belt concept (Conzen, 1960, pp. 58–9; Larkham, 1998, p. 159; Ünlü, 2013, p. 8), as these green spaces are an integral part of urban fringe-belt formation. The concept of the fringe belt is arguably the most important construct in Conzen's theory of urban area development. In the 1950s, Conzen analysed different physical forms within urban areas and mapped them based on the historical development of the town, defining the various units of the urban landscape (Whitehand, 2007, p. 19). A fringe belt 'develops essentially as a varied assortment of land-use units seeking peripheral location, mostly as latecomers in the town plan' (Conzen, 1981b, p. 46).

Conzen recognized several types of fringe belt according to their location within urban areas. The first or inner fringe belt surrounds the core of the historical town (Conzen, 1960, p. 58) and is mainly on or near the position of the fixation line – the town fortification. According to Conzen, the town wall as a fixation line divides the inner fringe belt into the space inside the wall – the intramural – and the space outside the wall – the extramural (Conzen, 1960, p. 59). The middle or intermediate fringe belt is separated from the inner fringe belt by other, generally residential, integuments (Conzen, 1960, p. 80). The most recent belt is the outer fringe belt (Conzen, 1960, p. 105).

Fringe belts were first identified as being associated with former fortification zones and it took only another short step to recognize their relationship to other planned features circumferential to the town, notably parkland belts and green belts (Whitehand and

Morton, 2002). Fringe belts are most visible in towns where there was a long recession in construction, combined with geographical obstacles, such as fortification zones and green belts (Whitehand, 1972; 1998, p. 126). Their green spaces are often associated with institutional buildings (Whitehand, 2001, p. 105).

The most important feature of the towns analysed here is their medieval walls. Very often these were followed by a circular road, built during a later period. In most cases the fortifications formed a fixation line which clearly marked the difference between the urban tissue outside and inside the fortifications, 'marking major limitations on the outward growth of the built-up area and heavily conditioning the pattern of subsequent growth' (Whitehand, 1981, p. 15).

In the case of fortified medieval and Renaissance towns with surviving fortifications, green spaces within the intramural fringe belt may take on the role of public green spaces with varied functions. Green spaces within this belt should fulfil three important functions: spatial integration in terms of connecting the immediate urban tissue into a compact whole, the function of social cohesion, and an ecological function.

In her study of Anatolian fortified towns, in relation to green spaces, Kubat (1997) focuses on the level of integration between the core of the town and its peripheral areas, which are often segregated and neglected, and have poor 'readability' of their cultural and historical value. The case study of Valencia is important because three different types of fringe belts exist within which there are significant green surfaces. Green spaces in different fringe belts of a town serve as a kind of 'glue' of the diverse urban tissue (Gómez *et al.*, 2011). The results of one research paper show that the presence of trees and meadows in urban spaces and the level of social activity offered there are a key component of neighbourhood vitality (Sullivan *et al.*, 2004).

The social aspect of fortified urban areas has an additional dimension because, as Conzen points out, in these dense structures constructed by human hand, it is important that

the daily experience of such an environment with which the local community continuously identifies is visually evident (Conzen, 1966). The residents of historical urban areas are the core of the town's vitality, and conservation of historical morphological entities relies on human activity in a town (Jones *et al.*, 2017).

The ecosystems within green spaces ensure a healthy environment by aiding both the psychological and physical health of people spending time there (Tzoulas *et al.*, 2007). As pointed out by Hopkins (2012, p. 41), who explored the ecological significance of fringe belts using the example of the Edwardian fringe belt in Birmingham, urban morphologists tend to deal only indirectly with this aspect of green spaces within fringe belts. He found that green spaces within the fringe belt were characterized by less large-scale disturbance, notably construction projects, than elsewhere in the urban area (Hopkins, 2012, p. 50). It is also suggested that these spaces at former edges of urban areas contribute to the semi-rural nature of the urban area and to intra-urban biodiversity (Whitehand and Morton, 2002)

Research method and selected findings

Of the 26 urban areas studied, 18 are in the Mediterranean region. Several countries were included in order to detect possible variability with regard to cultural, historical, geographical and climatic conditions.

Nine of the towns/cities have been inscribed on UNESCO's World Heritage List (Assisi, Bern, Bruges, Ferrara, Kotor, Corfu, Rhodes, San Gimignano and Siena), and three are on the Tentative List (Bergamo, Lucca and Ston).

Three Croatian towns (Ston, Cavtat and Nin) were the stimulus for researching other similar towns that have preserved their green spaces inside their town walls. Research was first expanded to Italy, Croatia's immediate neighbour, which was the source of architectural influences on fortifications, and Italian towns are of similar origin and have undergone similar transformations over time. The research was further expanded to a wider

Mediterranean area (Montenegro, Greece, Cyprus and Spain) to explore similarities and differences. Subsequently, the research expanded once again to include urban areas outside the Mediterranean region (Germany, Switzerland, Great Britain, Belgium and The Netherlands), aiming to investigate whether the principles of using and designing green spaces in all these towns are the same or similar, regardless of where these towns are located. The selected places are different topographically and some were planned and others spontaneously built.

Based on comparison of the 26 selected urban areas, the shape, location, size, relation of green spaces to the built-up areas, and the historical context were investigated. Modern orthophotographic maps were used, as well as nineteenth-century maps. The areas of the towns/cities within their walls, and the relationships between the built-up areas and the green areas were determined. The relationship between the amount of green space and, where the data were available, the number of residents inside the fortification was analysed.

A typological classification of green spaces was made using the criteria of size and intra-mural location. Based on the maps, drawings and information collected from various sources listed at the end of this paper, numerical data were tabulated (Tables 1 and 2). Table 3 presents data related to the cultural and historical context.

Geographical and morphological characteristics of towns

In the case of fortified places, green spaces are frequently part of the historical urban matrix and should be preserved in terms of position/location, shape and size. Research on the green spaces inside fortified places was preceded by an analysis of Renaissance and Baroque plans and detailed prints of townscapes (Obad Šćitaroci and Marić, 2015). This analysis served as the basis for determining the ratio between built-up tissue and green space in the past. The period of founding of a place refers to the creation of the

Table 1. Green spaces within fortifications

City or town	Size (ha) of urban area within fortifications	Green spaces (ha)	Green space within urban area (%)	Population inside fortifications (year)	Inhabitants (per ha)	Green spaces in m ² per capita
1. Assisi	70.15	31.47	44.86		285	
2. Bad Radkersburg	19.74	5.57	28.23	3093 (2015)	156	18
3. Bergamo	59.48	28.20	47.41	27 500 (2011)	458	10
4. Bern	93.27	13.81	14.81			
5. Binche	22.59	3.14	13.88			
6. Bruges	386.42	74.35	19.24	20 000 (2008)	51	37
7. Cavtat	20.47	12.90	63.01	450 (2011)	21	268
8. Conwy	9.68	1.49	15.48	3900 (2001)	402	3.8
9. Famagusta	58.00	21.09	36.37			
10. Ferrara	447.61	132.07	29.51	18 500 (2008)	41	71
11. Grosseto	21.78	5.00	22.99			
12. Kotor	16.21	2.07	25.78			
13. Corfu	44.57	13.25	29.72			
14. Lucca	130.91	33.76	25.79			
15. Madrigal de las Altas Torres	42.79	8.97	20.99	1544 (2014)	35	58
16. Morella	17.96	3.65	20.34	2854 (2007)	158	12
17. Neubrandenburg	40.29	10.07	25.00			
18. Nin	15.66	8.17	52.13	1132 (2011)	72	72
19. Nördlingen	53.30	4.96	9.32			
20. Pisa	204.02	38.50	18.87			
21. Portoferraio	17.94	2.98	16.65			
22. Rhodes	47.68	9.38	19.67	6000 (2011)	125	15
23. San Gimignano	21.35	7.05	33.00	7105 (2005)	338	9
24. Siena	173.53	63.69	36.70			
25. Ston	7.04	2.80	39.75	534 (2010)	76	52
26. Zierikzee	66.67	16.62	24.94			

Table 3. Degree of preservation of fortification system and historical urban tissue

City or town (State)	Founding period (c.)	Period of fortification construction (c.)	Preservation of fortification system (%)	Degree of preservation of historical layout and urban tissue (%)	Protected by UNESCO	Traffic within walls
1. Assisi (Italy)	11th	13th	85–100	85–100 historical, organic city matrix and urban tissue	+	+
2. Bad Radkersburg (Austria)	12th	16th	50	85–100 historical organic/orthogonal city matrix and urban tissue		+
3. Bergamo (Italy)	5th–14th	16th	85–100	85–100 historical organic city matrix and urban tissue	Tentative list 2006	+
4. Bern (Switzerland)	12th	12th–14th	Not preserved	85–100 preserved regular historical city matrix; Urban tissue 25–50	+	+
5. Binche (Belgium)	12th	12th–14th	85–100	Historical regular/organic matrix 85–100; Urban tissue 25		+
6. Bruges (Belgium)	9th	12th–16th–17th	25	Historical organic matrix 50; Urban tissue 25–50	+	+
7. Cavtat (Croatia)	15th	15th	25	Historical regular matrix/organic 85–100; Urban fabric 50		+
8. Conwy (UK)	13th	13th–15th	85–100	Historical regular matrix/organic 50; Urban tissue 25		+
9. Famagusta (N ^{ern} Cyprus)	3rd–13th–15th	13th–15th	85–100	Historical regular matrix/organic 25; Urban tissue 50		+
10. Ferrara (Italy)	8th–15th–16th	15th–16th	85–100	Historical regular matrix 85–100; Urban tissue 85–100	+	+
11. Grosseto (Italy)	9th–16th	16th	85–100	Historical organic matrix 85–100; Urban tissue 25		+
12. Kotor (Montenegro)	12th–14th	12th–18th	85–100	Historical urban matrix 85–100; Urban fabric 85–100	+	+
13. Corfu (Greece)	13th–17th	13th–15th–17th	85–100	Historical organic/planned matrix 85–100; Urban tissue 50	+	+
14. Lucca (Italy)	12th–15th–17th	Ancient ruins 11th–16th	85–100	Historical organic/planned matrix and urban matrix 85–100	Tentative list	+
15. Madrigal de las Altas Torres (Spain)	12th	13th–14th	50	Historical organic matrix 85–100; Urban tissue 25–50		+

Table 3. Continued

City or town (State)	Founding period (c.)	Period of fortification construction (c.)	Preservation of fortification system (%)	Degree of preservation of historical layout and urban tissue (%)	Protected by UNESCO	Traffic within walls
16. Morella (Italy)	11th	14th–15th 18th	85–100	Historical organic matrix 85–100; Urban tissue 25–50		+
17. Neubrandenburg (Germany)	12th–15th	14th	85–100	Historical organic matrix 85–100; Urban tissue 25		+
18. Nin (Croatia)	13th–15th	12th–14th	50	Historical planned/organic matrix 85–100; Urban tissue 25–50		+
19. Nördlingen (Germany)	13th–14th	14th	85–100	Historical organic matrix and Urban tissue 85–100		+
20. Pisa (Italy)	12th	12th 16th	50	Historical organic matrix 50; Urban tissue 25		+
21. Portoferraio (Italy)	13th 16th	16th	85–100	Historical planned matrix and Urban tissue 85–100		+
22. Rhodes (Greece)	13th–15th	14th–15th	85–100	Historical planned/organic matrix and Urban tissue 85–100	+	+
23. San Gimignano (Italy)	12th–13th	12th–13th	85–100	Historical organic matrix and Urban tissue 85–100	+	+
24. Siena (Italy)	12th–15th	12th–16th	50	Historical organic matrix and Urban tissue 85–100	+	+
25. Ston (Croatia)	14th	14th–16th	85–100	Historical organic matrix and Urban tissue 85–100	Tentative list	
26. Zierikzee (Netherlands)	12th	12th	25	Historical planned/organic matrix 85–100; Urban tissue 25–50		+

urban fortifications, although in the majority of cases a settlement existed in the very same place in ancient times.

Table 3 shows towns and cities according to their degree of preservation, the period when they were founded (this being in relation to the historical layout around which the fortification was built); the period when the fortification was built; the degree of preservation of the fortification system; the degree of preservation of the historical layout and urban tissue; UNESCO protection; and the presence or absence of traffic (stationary and moving) inside the fortification.

Terrain

The approach to planning in the plains differs from the approach to planning in hilly terrain (on a slope, ridge or plateau). Urban areas in the plains have fewer topographical variations than those in hilly terrain. This is most evident in their layouts. In places created in irregular terrain it was not possible to consistently identify orthogonal systems of streets. Street networks and house construction are adapted to topography. In the plains, a symmetrical layout often exists, along with a higher proportion of green spaces in different locations within the urban tissue. For example, green spaces in the historical parts of Bruges and Zierikzee are integrated in blocks of residential buildings in the urban core and their size increases with distance from the core (Figures 2 and 3). A similar relationship exists in Ferrara and Pisa (Figures 2 and 3). In the plains there is a tendency for stratification by historical periods to be pronounced. Lucca has a well preserved dense ancient urban tissue, which overlaps with the medieval one, and it is only towards the urban fringe that green spaces are found within street blocks (Figure 3).

In Corfu, between the fortifications on the land and those in the sea, a vast glacis was formed. At the time of fortifying the new section of the town, this glacis occupied a space inside the walls and has since been preserved in its original size of 5.5 hectares (Figure 3).

Urban areas developed on slopes, ridges or plateaus are characterized by densely built-up tissues: here green spaces in the more central areas are few. In such places as Siena (Figure 2) they are usually located between the edge of the built-up area and the walls.

Location

Places that present physical obstacles to expansion, either because they are located next to a river or surrounded by the sea, such as Bern (Figure 3) which lies on the bend of a river, or Cavtat (Figure 1) which lies on a peninsula, were not originally planned with larger green spaces inside their walls. Nin (Figure 1), located on an island, as nineteenth-century maps show, has green areas in the fringe belt, including arable land, vineyards and pastures.

Town foundation and fortifications

The majority of urban areas examined were built on ancient Roman foundations: Cavtat, Assisi, Bergamo, Bruges, Famagusta, Ferrara, Kotor, Corfu, Lucca, Nin, Nördlingen, Pisa, Portoferraio, Rhodes, San Gimignano and Siena. The remainder were founded in the Middle Ages: Bad Radkersburg, Bern, Binche, Conwy, Grosseto, Madrigal de las Altas Torres, Morella and Neubrandenburg. In the former, larger green spaces are located in the intramural inner fringe belt, along the walls. In Neubrandenburg the regular street pattern is of medieval origin. However, after the widespread destruction of buildings in the Second World War, most of the street blocks were redeveloped with centrally located green spaces that were much influenced in their rectilinear shapes by the medieval street pattern.

In three cases fortification remnants date back to the period of antiquity, but in the majority (22) the existing fortifications date back to the Middle Ages, and only one place has a fortification from the Renaissance period. According to the degree of preservation of the fortification, places with an entirely or almost



Figure 2. Green spaces in the urban tissue of the fortified towns of Ferrara, Bruges and Siena.

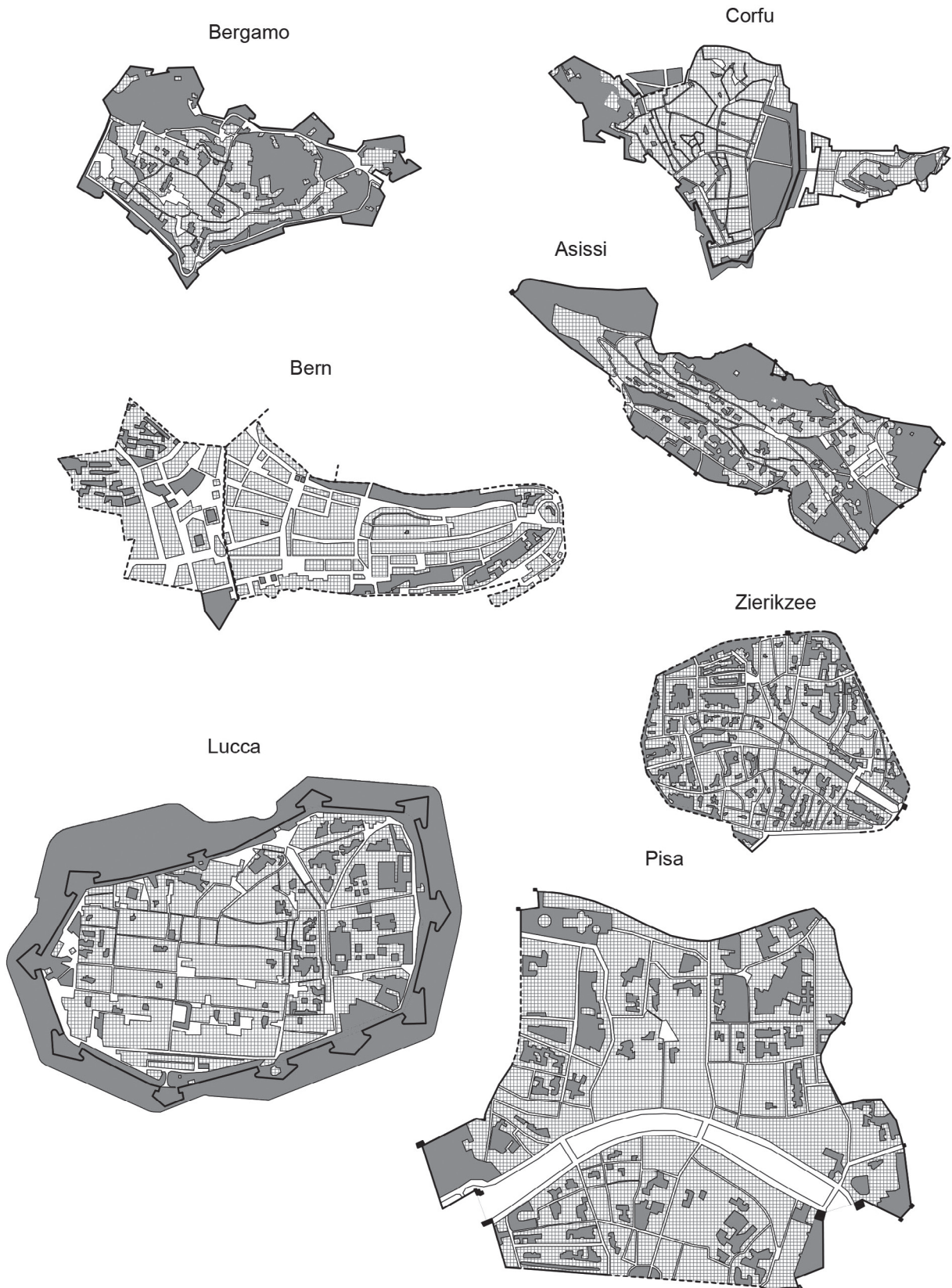
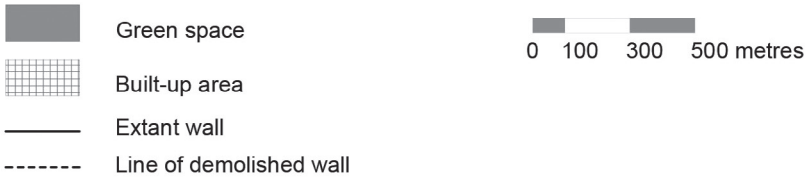


Figure 3. Green spaces in the urban tissue of the fortified towns of Bergamo, Corfu, Assisi, Bern, Zierikzee, Lucca and Pisa.

entirely preserved fortification predominate. Survival of over half the wall has occurred in five places (Bad Radkersburg, Madrigal de las Altas Torres, Nin, Pisa and Siena), while three places (Zierikzee, Cavtat, Bruges) have retained less than one-quarter of their fortifications, and just one (Bern) has not preserved any of its fortifications. Regardless of when fortifications were built and the level of their preservation, fringe belts form in much the same way. Despite the removal of the fixation line, mostly large green spaces remain in these locations.

Historical layout and green-space accessibility

Green spaces are important for the social cohesion and inclusiveness of towns, their civic identity and their quality of life (UN Habitat, 2015). One of the most important indicators of integration of the urban tissue and green spaces is accessibility, notably an adequate system of pedestrian communication to and within green spaces. In the case of Ston, the regular street system enables access to all the green spaces inside the town walls. A similar situation exists in Cavtat and Nin (Figure 1). In some places, the street network ends at the large green space in the fringe belt, and consequently there is a good connection between the central part of the town and these spaces. In some cases the former agricultural space has been transformed into a public park and has become a location for public gathering (Binche, Bruges and Zierikzee; Figures 1, 2 and 3).

Location, size, shape and type of green spaces within walls

Configurations have been analysed using the following criteria: surface area in hectares, number of inhabitants inside the fortification, population density per hectare, surface of green spaces inside the fortification, percentage of green spaces inside the fortification, and green space per inhabitant in square metres (Table 1).

In Table 2, urban areas are grouped according to the size and location of green space in relation to the town fortifications: continuous green spaces stretching between the edge of the built-up area and the walls; large compact green spaces at the edge of the built-up area; fragmented green spaces at the edge of the built-up area; smaller green spaces scattered within the urban tissue; large green spaces in the central area; and green spaces within the fortifications. Green spaces located on the town fortifications are related to the site of a former wall, bastion and/or glacis.

There was no correlation between the amount of green space and whether the urban area was orthogonally planned or organic. Both the organic and the planned places had roughly similar needs for green spaces in the past, and still do. The existence of green spaces inside the fortifications at the present time reflects the readiness to keep the original green spaces as components of the historical matrix, and the extent to which there has been a shift to developing beyond the historical areas. Where the historical layout and the historical urban tissue are preserved, the existing green space is an integral part of the original town structure (as, for example, in Kotor, Cavtat, Ston, San Gimignano and Assisi). This particularly applies to small and medium-sized towns (Figures 1 and 3) but is also evident in large urban areas in which green spaces were partly preserved in historical locations, such as in Ferrara (Figure 2). Historical maps reveal that Bruges used to be rich in green spaces, but when new streets and houses were built in the nineteenth century, many historical green spaces were lost. Some have become public parks (Baert *et al.*, 2012).

In terms of per capita green space, the Croatian towns of Cavtat, Nin and Ston (with 268 m², 72 m² and 52 m² per capita, respectively) have the largest amounts. According to the United Nations, the international standard is 30 m² of green space per capita (Laghai and Bahmanpour, 2012), and the European Union's standard is 26 m² of green space per capita (Vlad and Brătășanu, 2011). One of the European towns with the highest provision of

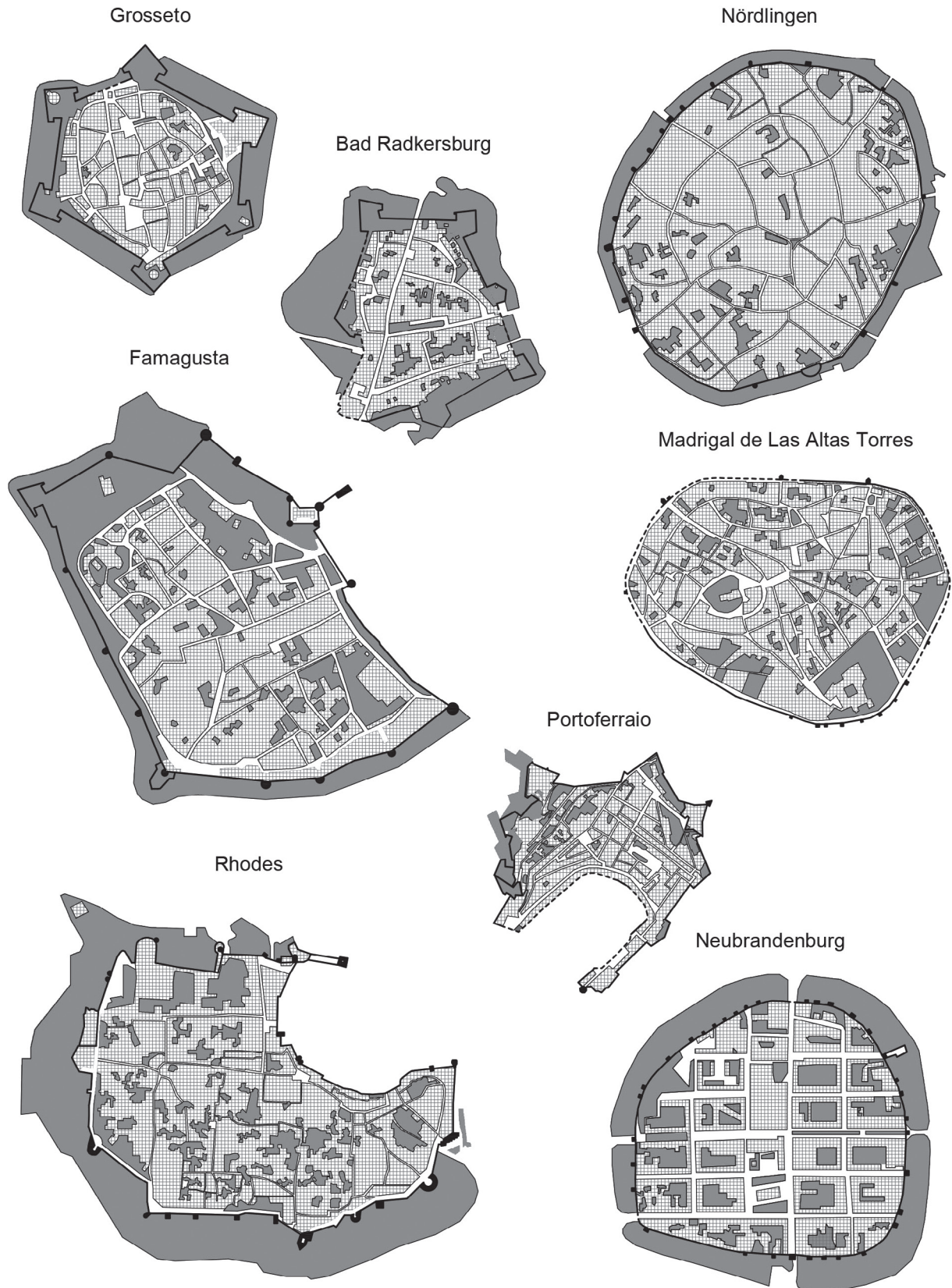
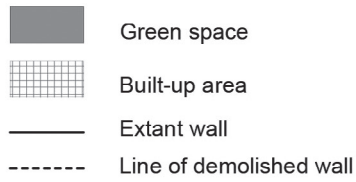


Figure 4. Green spaces in the urban tissue of the fortified towns of Grosseto, Bad Radkersburg, Nördlingen, Famagusta, Madrigal de las Altas Torres, Portoferraio, Rhodes and Neubrandenburg.

per capita green space is Aarhus, with approximately 200 m² of green space per capita (De Roo, 2011). According to the World Health Organization, cities should provide 9 m² per capita within 15 minutes of walking distance from homes (WHO, 2012).

Fourteen places have green spaces in the glacis of their fortifications. Regardless of fortifications forming a barrier between old and new, rings of avenues developed on their outer sides. The best examples of this are Lucca and Neubrandenburg, where the glacis was converted into a large park, outside the fortifications (Figures 3 and 4).

Among the different uses of green spaces (in and outside the inner fringe belt) are public gardens, private gardens, walkways, agricultural areas, archaeological zones, semi-natural vegetation, undefined spaces, natural landscapes, sports grounds and car parks.

Conclusion

This research has shown that green spaces between the urban core and town and city walls are important aspects of the intramural inner fringe belts. In their absence an important component in the appreciation of the historical urban matrix is lacking. It is important to conserve these green spaces and promote their present-day use in ways that maintain historical inner fringe belts.

The research has confirmed that green spaces have a significant presence inside the fortifications of medieval and Renaissance towns and cities in Europe, offering great potential for these places. Of the urban areas analysed, the large majority are characterized by a high degree of preservation of their old established layouts and urban tissue. Green spaces located at the edge of the town, including those associated with religious buildings, may be considered as original green spaces of the medieval and Renaissance town – part of the first, intramural inner fringe belt. Large compact green spaces at the edge of the urban area exist in 19 of the places studied, continuous green spaces between the edge of the built-up area and the walls exist in 12 cases,

while 14 places have green spaces in the glacis of the fortification.

The classification of green spaces has revealed that in the Middle Ages and early Renaissance (when the majority of the urban areas studied were fortified) many of these spaces were initially used, at least to some extent, for defensive purposes. Some were used to provide food in the event of a prolonged siege, and some as reserve land for expansion. Some that were set aside for expansion have not been built on because the built-up area has not reached its anticipated size. Through the nineteenth and twentieth centuries, spaces excluded from development to allow for town expansion have been used for various purposes: public green spaces (gardens, walkways, children's playgrounds, sports fields); private gardens; non-maintained green spaces that have grown into groves/woods; spaces still used as utilitarian areas for growing garden crops; and green spaces identified as protected areas. Small towns, up to 50 ha in size, have a relatively large proportion of green space. This is largely a reflection of low pressure for new construction.

As important parts of inner fringe belts, green spaces afford a direct connection with the histories of their towns. As such they are an important aspect of urban identities and should be conserved.

In revealing the current state of green spaces in the inner fringe belt of a significant number of European towns and cities, this research is a starting point for developing scenarios of active conservation. Such conservation should entail preserving the original location, configuration and size of these fringe belts. The original purpose of the green spaces should not be ignored in the renewal and management processes of these historical urban areas. Future uses of neglected green spaces should be considered in relation to both the built immediate spatial context and the urban area in its entirety. This should include how these spaces should be integrated into their immediate surroundings, their connection to the centre of the urban area, and their role in social cohesion.

The typology of green spaces within historical urban tissue will be the subject of future research. This research should be directed towards defining the criteria for establishing the future purposes of green spaces. They have the potential to create efficient and attractive places and should not be considered separately from the urban tissue as a whole.

Acknowledgements

The research presented in this paper was supported by funding by the Croatian Science Foundation of the project Heritage Urbanism-Urban and Spatial Models for Revival and Enhancement of Cultural Heritage (HERU-2032).

References

- Baert, S., Beernaert, B., Deschaumes, C., Leye, I. and Nauwelaerts, J. (eds) (2012) *Bruges world heritage city* (Spatial Planning Department, UNESCO Sector, Department of Heritage Conservation, Bruges).
- Conzen, M. R. G. (1960) *Alnwick, Northumberland: a study in town-plan analysis* Institute of British Geographers Publication 27 (George Philip, London).
- Conzen, M. R. G. (1966) 'Historical townscapes in Britain: a problem in applied geography', in House, J. W. (ed.) *Northern geographical essays in honour of G. H. J. Daysh* (Department of Geography, University of Newcastle upon Tyne, Newcastle upon Tyne) 56–78.
- Conzen, M. R. G. (1981a) 'The morphology of towns in Britain during the industrial era', in Whitehand, J. W. R. (ed.) *The urban landscape: historical development and management. Papers by M. R. G. Conzen* Institute of British Geographers Special Publication 13 (Academic Press, London) 87–126.
- Conzen, M. R. G. (1981b) 'The plan analysis of an English city centre', in Whitehand, J. W. R. (ed.) *The urban landscape: historical development and management. Papers by M. R. G. Conzen* Institute of British Geographers Special Publication 13 (Academic Press, London) 25–53.
- De Roo, M. (2011) *The green city guidelines: techniques for a healthy liveable city* (Department of Urban and Regional Planning, University of Wageningen, The Netherlands).
- Doratli, N. (2005) 'Revitalizing historic urban quarters: a model for determining the most relevant strategic approach', *European Planning Studies* 13, 749–72.
- Ducom, E. (2003) 'Fringe belts and planning: a French example', *Urban Morphology* 7, 103–4.
- Ducom, E. (2005) 'Processes of urban change: planning and monitoring strategies through the application of the fringe belt model to Nantes and Rennes, France', unpublished paper presented to the IGU Conference Tokyo, Japan, 7–23.
- Dunnett, N., Swanwick, C. and Woolley, H. (2002) *Improving urban parks, play areas and green spaces* (Department for Transport, Local Government and the Regions, London).
- Gómez, F., Jabaloyes, J., Montero, L., De Vicente, V. and Valcuende, M. (2011) 'Green areas, the most significant indicator of the sustainability of cities: research on their utility for urban planning', *Journal of Urban Planning and Development* 137 (3), 311–28.
- Hazar, D. and Kubat, A. S. (2015) 'Fringe belts in the process of urban planning and design: comparative analyses of Istanbul and Barcelona', *A/Z, Journal of the Faculty of Architecture, Istanbul Technical University* 12, 53–65.
- Hopkins, M. I. W. (2012) 'The ecological significance of urban fringe belts', *Urban Morphology* 16, 41–54.
- Jones, P., Isakjee, A., Jam, C., Lorne, C. and Warren, S. (2017) 'Urban landscapes and the atmosphere of place: exploring subjective experience in the study of urban form', *Urban Morphology* 21, 29–40.
- Krajnik, D. (2011) *The transformation of bastion forts in European and Croatian towns* (Faculty of Architecture, University of Zagreb, Zagreb).
- Krajnik, D. and Obad Šćitaroci, M. (2008) 'City fortifications and the form of European cities, with special reference to Croatia', *Urban Morphology* 12, 117–29.
- Krajnik, D., Obad Šćitaroci, M. and Šmit, K. (2008) 'Preobrazba gradskih utvrda u javne prostore urbane društvenosti' ('The transformation of city fortresses into public urban spaces') *Društvena istraživanja (Journal of General Social Issues)* 17, 463–82.
- Kropf, K. (1996) 'Urban tissue and the character of towns', *Urban Design International* 1, 247–63.
- Kubat, A. S. (1997) 'The morphological characteristics of Anatolian fortified towns', *Environment and Planning B: Planning and Design* 24, 95–123.

- Laghai, H. A. and Bahmanpour, H. (2012) 'GIS application in urban green space per capita evaluation (Case study: City of Tehran)', *Annals of Biological Research* 3 (5), 2439–46.
- Larkham, P. J. (1998) 'Urban morphology and typology in the United Kingdom', in Petruccioli, A. (ed.) *Typological process and design theory* (Aga Khan Program for Islamic Architecture, Cambridge, MA) 159–77.
- Obad Šćitaroci, M. and Marić, M. (2015) 'Landscape areas of fortified medieval and Renaissance towns', in Obad Šćitaroci, M. (ed.) *Proceedings of the International Conference: Cultural heritage – Possibilities for spatial and economic development* (Faculty of Architecture, University of Zagreb, Zagreb) 90–5.
- Oktay, D. and Conteh, F. M. (2007) 'Towards sustainable urban growth in Famagusta', unpublished paper presented to the International Conference of the European Network for Housing Research on Sustainable Urban Areas, Rotterdam, The Netherlands, 25–28 June.
- Olivera, V. (2016) *Urban morphology: an introduction to the study of the physical form of cities* (Springer International, Cham, Switzerland).
- Planić-Lončarić, M. (1980) *Planirana izgradnja na području Dubrovačke republike (Planned construction in the territory of the Dubrovnik republic)* (Institute for the History of Art, Zagreb).
- Planić-Lončarić, M. (1987) 'Ston – primjer srednjovjekovnoga prostornog planiranja' ('Ston – an example of medieval spatial planning'), in Zvjerković, P. (ed.) *Zbornik radova u cast 650. obljetnice planske izgradnje Stona i Maloga Stona (Proceedings of the 650th anniversary of the planned construction of Ston and Little Ston)* Ston: Mjesna zajednica 'Ston' (Ston: Local community 'Ston') 57–64.
- Sullivan, C. W., Kuo, F. E. and Depooter, F. S. (2004) 'The fruit of urban nature: vital neighborhood spaces', *Environment and Behavior* 36, 678–700.
- Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemela, J. and James, P. (2007) 'Promoting ecosystem and human health in urban areas using green infrastructure: a literature review', *Landscape and Urban Planning* 81, 167–78.
- Ünlü, T. (2013) 'Thinking about urban fringe belts: a Mediterranean perspective', *Urban Morphology* 17, 5–20.
- UN Habitat (2015) *Adequate open public space in cities: a human settlements indicator for maintaining the post-2015 Sustainable Agenda*, a presentation of the UN Human Settlements Program, New York, 25–26 February.
- Vlad, M. I. and Brătășanu, D. (2011) 'Quality of life assessment based on spatial and temporal analysis of the vegetation area derived from satellite images', *Romanian Review of Regional Studies* 7, 111–20.
- Walsh, M. J. K., Coureas, N. and Edbury, P. W. (2012) *Medieval and Renaissance Famagusta: studies in architecture, art and history* (Routledge, Abingdon).
- Whitehand, J. W. R. (1972) 'Urban-ment theory, time series and morphogenesis: an example of eclecticism in geographical research', *Area* 4, 215–22.
- Whitehand, J. W. R. (1981) 'Background to the urban morphogenetic tradition', in Whitehand, J. W. R. (ed.) *The urban landscape: historical development and management* Institute of British Geographers Special Publication 13 (Academic Press, London) 1–24.
- Whitehand, J. W. R. (1998) 'Continuity and discontinuity in the urban landscape: a geographer's view', in Petruccioli, A. (ed.) *Rethinking the XIXth century city* Aga Khan Program for Islamic Architecture (Cambridge, MA) 121–9.
- Whitehand, J. W. R. (2001) 'British urban morphology: the Conzenian tradition', *Urban Morphology* 5, 103–9.
- Whitehand, J. W. R. (2007) 'Conzenian urban morphology and urban landscapes', in Kubat, A. S., Ertekin, Ö., Güney, Y. İ. and Eyüboğlu, E. (eds) *Proceedings of the 6th international space syntax symposium* vol. 1 (Faculty of Architecture, Istanbul Technical University, Istanbul) 18–26.
- Whitehand, J. W. R. and Alauddin, K. (1969) 'The town plans of Scotland: some preliminary considerations', *Scottish Geographical Magazine* 85, 109–12.
- Whitehand, J. W. R. and Gu, K. (2010) 'Conserving urban landscape heritage: a geographical approach', *Procedia Social and Behavioral Sciences* 2, 6948–53.
- Whitehand, J. W. R. and Morton, N. J. (2002) 'Fringe belts and the recycling of urban land: an academic concept and planning practice', *Environment and Planning B: Planning and Design* 30, 819–39.
- World Health Organization (WHO) (2012) *Health indicators of sustainable cities in the context of Rio+20 UN conference on sustainable development* WHO/HSE/PHE/7.6.2012f.

Archival sources for Cavtat, Nin and Ston

Austrian Francescan Cadastre, 1832, Archive of Maps for Istria and Dalmatia, State Archives in Split.

Orthophotographic images and Google maps 2015

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Binche (Belgium), 6. Bruges (Belgium), 7. Cavtat (Croatia), 8. Conwy (United Kingdom), 9. Famagusta (Northern Cyprus), 10. Ferrara (Italy), 11. Grosseto (Italy), 12. Kotor (Montenegro), 13. Corfu (Greece), 14. Lucca (Italy), 15. Madrigal de las Altas Torres (Spain), 16. Morella (Italy), 17. Neubrandenburg (Germany), 18. Nin (Croatia), 19. Nördlingen (Germany), 20. Pisa (Italy), 21. Portoferraio (Italy), 22. Rhodes (Greece), 23. San Gimignano (Italy), 24. Siena (Italy), 25. Ston (Croatia), 26. Zierikzee (Netherlands).
